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WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : D21H 27/38, 15/10, B32B 29/00

A1

(11) International Publication Number: WO 93/14267

(43) International Publication Date: 22 July 1993 (22.07.93)

(21) International Application Number: PCT/US93/00205

(22) International Filing Date: 19 January 1993 (19.01.93)

(30) Priority data:
823,103 21 January 1992 (21.01.92) US

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(81) Designated States: European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
With amended claims.

(54) Title: REINFORCED ABSORBENT PAPER

(57) Abstract

A wetlaid multiple-layer reinforced absorbent towel or tissue paper including wood pulp and straight long synthetic fibers. One method of making the reinforced paper includes forming first and second slurries of wood pulp fibers and a third slurry of long synthetic thermal bonding fibers, wet-laying the three slurries to form a layered web having outer layers of wood pulp fibers and a central layer of synthetic fibers contiguous to the outer layers, and thermally bonding the synthetic fibers to each other and to the wood pulp fibers. In accordance with another embodiment of the invention, the method includes making a multiple layer reinforced paper by wet-laying first and second two-layer webs (each such two-layer web including one layer having thermal bonding fibers), drying and then creping the two-layer webs to get loft and softness, and positioning the first two-layer web atop the second two-layer web so that their respective bonding fiber layers are contiguous to form a two-ply web. The two-ply web is heated to adhere the first and second two-layer webs to each other and to thus form a thermally-bonded reinforcing layer.

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REINFORCED ABSORBENT PAPER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to reinforced absorbent paper, especially to reinforced tissue or toweling.

Description of the Related Art

Reinforced tissue is typically reinforced off-machine. A reinforced tissue called Kaycel, for example, manufactured by Kimberly-Clark Corporation, uses a scrim of fine denier continuous filaments coated with adhesive, which scrim is layered between sheets of tissue and melted.

Scrim-reinforced tissue suffers from several disadvantages, including the cost of materials of the scrim itself, the cost of manufacturing the scrim, and the cost of the separate off-machine layering. In addition, scrim-reinforced product suffers from poor abrasion resistance manifested in a phenomenon called "windowing". When used as a wipe, small squares of tissue are abraded off of the wipes and remain deposited on, e.g., a patient's skin. If one then examines the wipe, one observes what appear to be small window-like openings in the wipe. This windowing is apparently due to the manner of reinforcing the paper. The scrim reinforces the tissue only at those places where the continuous filaments of the scrim contact the tissue.

Hence, a need exists for a reinforced absorbent paper that is less expensive to manufacture and that exhibits greater abrasion resistance.

SUMMARY OF THE INVENTION

The present invention provides a reinforced paper that is reinforced on-machine, that exhibits good abrasion resistance, and that is economical to manufacture. Additional objects and advantages of the present invention will be apparent from the description, may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims, and may be learned by practice of the invention.

In its broadest sense, the present invention relates to a reinforced absorbent paper comprising outer surfaces composed predominately of absorbent wood pulp fibers and an inner structure containing sufficient fused thermoplastic fibers to provide a reinforcement structure. A prime economic advantage of the present invention is that the reinforced absorbent paper components can be made entirely on a paper machine - that is, the reinforcement structure can be made by wetlaid processing. A prime product performance advantage of the present invention is that the reinforcement structure tends to be micro-uniform and inobtrusive. By "micro-uniform", I mean uniform at the level of product usage, as opposed to a scrim-reinforced absorbent paper, which shows areas of high and low (or non-existent) strength when used for instance in a wiping application. By "inobtrusive", I mean that the reinforcement structure is not readily differentiable from the absorbent paper itself as a scrim reinforcement would tend to be.

One method of making multiple-layer reinforced paper according to the present invention comprises the steps of forming first and second slurries of fibers including wood pulp fibers; forming a third slurry of fibers including long synthetic thermal bonding fibers; wetlaying the first, second, and third slurries to form a layered web having first and second outer layers of fibers including wood pulp fibers and a central layer of fibers including long synthetic fibers contiguous to the first and second layers; and bonding the synthetic fibers of the central layer to each other and to the wood pulp fibers of the first and second outer layer.

The present invention comprises the steps of wetlaying first and second two-layer webs, each two-layer web including one bonding fiber layer having thermal bonding fibers; drying the first and second two-layer webs; creping the first and second two-layer webs; positioning the first two-layer web and the second two-layer web so that their respective bonding fiber layers are contiguous to form a two-ply web; and heating the two-ply web to adhere the first and second two-layer webs to each other and to form a bonded reinforcing layer.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principle of the invention.

Fig. 1 is a schematic cross-sectional end view of a three-channel headbox.

Fig. 2 is a schematic cross-section of a multiple-channel headbox.

Fig. 3 is a diagrammatic illustration of a three-layer stratified web of reinforced paper according to one embodiment of the invention.

Fig. 4 is a perspective view of a pair of two-layer webs.

Fig. 5 is a perspective view showing the pair of webs of Fig. 4 positioned atop each other.

Fig. 6 is a perspective view of a three-layer stratified web of reinforced paper produced from the web of Fig. 5 according to still another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

PROCESSING

All of the alternative methods according to the present invention include the step of forming a slurry of fibers including long synthetic thermal bonding fibers, preferably in accordance with the method taught in U.S. Patents Nos. 4,925,528 and 4,822,452 (incorporated herein by reference). The furnish may optionally also include an anionic polymer dispersion aid, such as Calgon's Hydraid, The slurry is then wetlaid to form a web comprising said long synthetic fibers. Finally the synthetic fibers are bonded to each other and to the wood pulp fibers.

"Wetlaid" processing as contemplated herein may be conventional water-based papermaking; it may also be foam-forming, that is, a variant of water-based papermaking in which a substantial amount of the water carrier is replaced by air bubbles engendered by the presence of surfactant.

The bonding step may include using a Yankee dryer, passing the web through dryer cans, hot calendering, or through-air drying, all as is known. The bonding step may also include embossing the web before

collecting the web on a take-up reel, again as known. For some applications, it is preferred that the drying step include drying each of two two-layer webs 70 (Fig. 5) on a Yankee dryer so that thermal bonding fiber layer 74 is positioned remote from the Yankee dryer surface. After the two-layer webs 70 are combined into two-ply web 76 (Fig. 6), web 76 may be heated by having the last section of drier cans hot enough or by passing web 76 through a hot calender, a hot embosser, or a through-air dryer in order to bond the thermal bonding fibers. A three-layer web such as web 50 (Fig. 3) also may be heated by those techniques to bond the thermal bonding fibers to each other and to the wood pulp fibers.

THREE LAYERS

To produce a three-layered embodiment of the invention, a three-channel headbox, such as that illustrated in Fig. 1, may be used. In that headbox 10, slurry supply pipes 16, 18, and 20 receive slurries from cross-machine distributors 14 and supply said slurries to mixing chambers 22 and tube banks 24 of headbox 10. In one embodiment, slurry from a single source is supplied to pipes 16 and 20, which will result in identical outer layers in the web when it is wet-laid. A different slurry is supplied by pipe 18 to form an inner layer in the web. The slurries from pipes 16, 18, and 20 are kept separate by layering plates 32 and the slurries from the three pipes 16, 18, and 20 to exit at outlet (or "slice") 26. The separation distance between layering plates 32 at slice 26 may be adjusted by slice jack 28 and slice knuckle 30. The composite slurry that issues from the headbox is deposited on e.g., a Fourdrinier wire forming section, a twin-wire machine, or some other conventional papermaking machine.

Preferably, the headbox is a Beloit Concept II headbox such as StrataFlo headbox commercially available from Beloit Corporation. An

example of such a headbox is illustrated in Fig. 2, showing tube bank 24 for dividing the total flow of the slurry into multiple thin converging layers, trailing elements 34, and slice 26. Another preferred headbox is the Beloit Contra-Flo.

Fig. 3 schematically illustrates a three-layer stratified web 50 having outer wood pulp fiber layers 52 and 56, which are preferably substantially identical to each other, and a central layer 54 of long synthetic fibers positioned between outer layers 52 and 56. In actuality, of course, there is a diffusion or blinding at the boundaries between the layers of the webs as opposed to the sharp lines illustrated in Figs. 3-7.

THE FIBERS

Referring to Fig. 3, to produce the three-layered stratified web 50, outer layers 52 and 56 are made from a slurry preferably containing predominantly wood pulp fibers. Substantially any known wood pulp fibers may be used. Central layer 54 is made from a slurry preferably containing predominately long synthetic thermal bonding fibers. Although any synthetic thermal bonding fibers can be used, bicomponent fibers such as sheath/core or side-by-side biocomponent fibers wherein there is a lower melting component and a higher melting component with a significant proportion of the surface of the fiber being the lower melting component, are preferred. Sheath/core bicomponent fibers are generally most preferred because they exhibit a better bonding efficiency than side-by-side bicomponent fibers, and because in some cases side-by-side bicomponent fibers may exhibit an excessive tendency to curl, crimp, or shrink during the heat bonding step. Such three-dimensionalization of the thermal bonding fibers is to be avoided, because as the fibers lose their straightness, they likewise lose ability to reinforce the paper product into

which they are incorporated. For this reason, concentric sheath/core bicomponent fibers are much preferred to eccentric ones. Sheath/core bicomponent fibers especially useful according to the present invention are preferably selected from the group consisting of polyethylene/polyester, co-polyester/polyester, polypropylene/polyester, and polyethylene/polypropylene. It is preferred that the synthetic fibers be selected from the Celbond family of bicomponent fibers such as K56, T105, or T106 commercially available from Hoechst Celanese. The K56 and T106 fibers are bicomponent fibers having a sheath of polyethylene and a core of polyester and having dimensions of about 10 mm by about 2 denier (that is, about three to four times longer than the wood pulp fibers and about one-half the diameter of the wood pulp fibers). The T105 fiber, a biocomponent fiber that is chemically reactive with cellulose, is believed to have a sheath including polyolefin and a core of polyester and has dimensions of about 1/2 inch by about 2 denier.

As used in this description, the term "long" synthetic fibers means fibers having a length-to-diameter ratio of at least about 500 to 1. In one preferred embodiment, the length-to-diameter ration is at least 800; a length-to-diameter ratio ranging from 1600 to 1 represents the approximate upper limit of typical manufacturing equipment for end use such as wipes. It is preferred that the long synthetic fibers be randomly laid down, nonwoven, cut fibers. The long synthetic fibers should have a length of from about 6 mm to about 30 mm, and should have a size in the range of from about 0.5 denier to about 15 denier.

The percentage of the synthetic fibers in the web could range from about 5% to about 60% by weight of the overall absorbent paper product. Preferably, the synthetic thermal bonding fibers should compose about %5

to about 20% of all the fibers in the web. In addition to the bicomponent synthetic fibers in central layer 54, that layer could include wood pulp fibers or hydrophilic wood pulp, or synthetic fibers such as non-bonding fibers, synthetic pulps, or bonding fibers such as homopolymers or biconstituent fibers.

Similarly, the percentage of wood pulp fibers in the overall product could range from about 40% to about 95% by weight. Thus, in addition to the wood pulp fibers in outer layers 52 and 56, those layers could include synthetic fibers. Preferably, the wood pulp fibers should compose at least 50% by weight of all the fibers in the web for end use products such as tissues or wipes. In other words, although it appears that the present invention would yield a reinforced web even if the wood pulp fibers were less than 50% by weight of all the fibers in the web, as the percentage of wood pulp fibers decreases from 50% the resulting web would lose aesthetic properties associated with paper.

<u>COMBINING WEBS</u>

In accordance with another embodiment of the invention, using the same types of fiber, the method includes making a multiple layer reinforced paper by wet-laying first and second two-layer webs (each such two-layer web including one layer having thermal bonding fibers), drying and then creping the two-layer webs to get loft and softness, and positioning the first two-layer web atop the second two-layer web so that their respective bonding fiber layers are contiguous to form a two-ply web. The two-ply web is heated to adhere the first and second two-layer webs to each other and to thus form a thermally bonded reinforcing layer.

As illustrated in Fig. 4, each two-layer web 70 is wetlaid and includes a wood pulp fiber layer 72 and a thermal or chemical bonding

fiber layer 74. After first and second two-layer webs 70 are dried and creped, they are positioned as illustrated in Fig. 5 so that their respective bonding fiber layers 74 are contiguous to form a two-ply web 76. Two-ply web 76 is heated to adhere or bond first and second webs 70 to each other; the respective bonding fiber layers 74 thus form a thermally bonded reinforcing layer 78 as illustrated in Fig. 6, thereby producing a three-layer stratified reinforced paper 80. In this embodiment, the percentage of long synthetic fibers in the web could range, again, from about 5% to about 60% by weight; the preferable range is about 5-20%.

THE PRODUCTS

The desired percentage of such wood pulp and synthetic thermal bonding fibers in the web may vary depending on the end use of the product. For example, for consumer use products in a kitchen (where softness is more desirable than strength), it is preferable to use about 5-10 % synthetic fibers. For commercial use products in a mechanic's shop (where strength is more desirable than softness), it is preferable to use about 20% synthetic fibers.

It is also preferred that the finished product have a basis weight in the range of about 5 pounds per ream to about 30 pounds per ream (for ream of 3000 square feet). Paper heavier than 30 pounds per ream could be advantageously produced by the method of this invention, although such a heavier paper may not be regarded as tissue. It will be appreciated that the invention is not limited to a reinforced paper having only three layers. A multi-layer reinforced paper having four or even more layers may be produced by the method of the present invention.

EXAMPLES

A stratified web was produced on a pilot scale twin-wire former using a Beloit Contra-Flo three-layer headbox to provide a reinforced tissue. The furnish for the outer layers consisted of 1500 pounds of 50% northern hardwood kraft and 50% northern softwood kraft. The center layer of the three-ply web was 100% DuPont dacron type 271P, a 4.0 denier x 3/4 inch thermal bonding biocomponent fiber, possessing a copolymer PET sheath and a PET core. One hundred fifty pounds of the synthetic fiber was treated in a pulper containing 2000 gallons of 90°F water with 6.7 pounds of a nonionic associative thickener (Acrysol QR-708, 34% active, Rohm & Haas, Philadelphia, Pa. -- a polymeric surfactant), and 133 gallons of a 0.6% solution of an anionic polymer sold under the trade name Hydraid 7300C by Calgon, Inc., Pittsburgh, Pa. The contents of the pulper was pumped over to a first machine chest where it was filled with water to a volume of 8000 gallons. This provided a chemical concentration of 100 ppm of each of the QR-708 nonionic associative thickener and 7300C anionic polymer. The kraft pulps were then mixed with water in the pulper and the blend was sent over to a second machine chest. The furnishes were pumped separately to the headbox to form a layered structure. (The synthetic fiber furnish was pumped to the suction side of the fan pump.) Bonding occurred as the web passed over a Yankee dryer heated to 305°F (a steam pressure of 76 psig). That temperature allowed the sheath of the bicomponent fiber to soften and flow, thus providing bonds between the fibers. A control, in the form of the two outer plies with water for the center layer, was run at the beginning of the trial at 2500 fpm, with a 20% crepe and a basis weight of

22 lb/3000 sq. ft. Two reels of the three-ply substrate were produced with the center layer making up 6% and 8%, respectively, of the weight of the sheet with the final basis weight coming out to 24 and about 25 lb/3000 sq. ft., respectively. These two reels were also run with a wire speed of 1500 fpm and a 20% crepe. The physical properties of the webs are shown in Table I.

Table 1

Physical Properties of Three-Ply Reinforced Tissue

Two Ply Center Ply Bottom Ply	50% NHVK/50% NSWK -- 50% NHVK/50% NSWK	50% NHVK/50% NSWK 100% bicomponent fiber (6% of sheet) 50% NHVK/50% NSWK	50% NHVK/50% NSWK 100% bicomponent fiber (8% of sheet) 50% NHVK/50% NWSK
BASIS WEIGHT (lb/rm):	22.4	24	24.8
CALIPER (mils):	10.9	10	10.3
BULK (cm^3/g):	7.56	6.51	6.45
FRAZIER AIR PERM. (cfm):	35	45	36
ELONGATION (%): MD CD	50.7 3.4	31 3.4	36.9 3.4
DRY STRIP TENSILE (g/3 in): MD CD GM	1280 690 940	1552 555 928	1896 651 1111
WET STRIP TENSILE (g/3 in): MD CD GM	100 55 74	440 84 192	817 157 358
DRY BREAKING LENGTH (m): (geo.mean)	338	312	361
WET BREAKING LENGTH (m): (geo.mean)	27	65	116
TEAR (g): MD CD	9 *	28 *	41 *
MULLEN (psi):	**	7.7	9.2

* Did not tear in area specified
** Could not lift from water

Table II identifies the TAPPI standard test methods used. The test methods are described in TAPPI standard test methods.

TABLE II

Measured Properties	Test Method	Units
Basis Weight	M-410	lb/3000 sq. ft.
Caliper	M-411D	.001"
Bulk		cm^3/g
Tensile Strength	M-404	g/3 in
Elongation	M-404	%
Frazier Air Permeability	M-060	CFM

Breaking length and geometric mean tensile strength are calculated values. Conceptually, breaking length is the greatest length of paper that would support its own weight. Breaking length (in meters) is calculated from basis weight (in pounds per 3000 square feet) and from the geometric mean tensile strength (in grams per inch), which in turn is calculated from the value for MD & CD strip tensile strength (in grams per inch) as follows:

$$\text{breaking length} = 24.23 \times \text{geometric mean tensile strength} \div \text{basis weight}$$

$$\text{geometric mean tensile strength} = \sqrt{\text{MD strip tensile strength} \times \text{CD strip tensile strength}}$$

Thus, for the sheet including 6% bicomponent fiber (column B in Table I), geometric mean tensile strength (calculated from the dry tensile strength values in Table I) is 309 g/in, and the dry breaking length is calculated to be about 312m. Similarly geometric mean tensile strength

calculated from the wet tensile strength values in Table I is 64 g/in, and the wet breaking length is calculated to be about 65m.

For the sheet including 8% bicomponent fiber (column C in Table I), the geometric mean tensile strength (calculated from dry tensile strength values in Table I) is 370 g/in, and the dry breaking length is calculated to be about 361m. Similarly, geometric tensile strength calculated from the wet tensile strength values in Table I is 119 g/in, and the wet breaking length is calculated to be about 116m.

Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and the practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary and explanatory only, with a true scope and spirit of the invention being indicated by the following claims.

I CLAIM

1. A multiple-layer reinforced absorbent paper towel or tissue product having a basis weight in the range of from about 5 pounds to about 30 pounds per ream of 3000 square feet comprising

absorbent outer layers comprised predominately of wood pulp fibers, and

an inner reinforcing structure comprising wetlaid straight synthetic thermal bonding fibers thermally bonded to at least one said outer layer and to one another.

2. A reinforced absorbent paper according to claim 1 in which said straight synthetic thermal bonding fibers compose from about 5% to about 20% by weight of all of the fibers in the web.

3. A reinforced absorbent paper according to claim 1 in which said outer layers comprise predominately hardwood and softwood kraft fibers and said inner reinforcing structure comprises long bicomponent fibers selected from the group consisting of polyethylene/polyester, co-polyester/polyester, polypropylene/polyester, and polyethylene/polypropylene.

4. A reinforced absorbent paper according to claim 3 in which the bicomponent fibers are about 1/2 inch in length and have a denier of about 2.

5. A three-layer reinforced absorbent paper according to claim 1 in which the absorbent outer layers consist essentially of wood pulp fibers and the inner reinforcing structure consists essentially of sheath/core bicomponent synthetic thermal bonding fibers.

6. A method of making three-layer reinforced paper according to claim 5 comprising the steps of:

forming first and second slurries of fibers including wood pulp fibers;

forming a third slurry of synthetic thermal bonding fibers including long synthetic thermal bonding fibers;

wetlaying said first, second, and third slurries to form a layered web having first and second outer layers of fibers consisting essentially of said wood pulp fibers and a central layer of fibers consisting essentially of said synthetic fibers contiguous to said first and second outer layers; and

thermally bonding the synthetic fibers of the central layer to each other and to the wood pulp fibers of the first and second outer layers.

7. A reinforced absorbent paper according to claim 1 in which each of the absorbent outer layers consists essentially of the wood pulp fiber layer of a two-layer web and in which the inner reinforcing structure consists essentially of two conjoined thermally bonded synthetic fiber layers of said two-layer webs, wherein each said two-layer webs consists essentially of one layer consisting essentially of wood pulp fibers and one layer consisting essentially of synthetic thermal bonding fibers.

8. A method of making a reinforced paper according to claim 7 comprising the steps of:

wetlaying first and second two-layer webs, each two layer web including one bonding fiber layer having thermal bonding fibers;

drying said first and second two-layer webs;

creping said first and second two-layer webs;

positioning said first two-layer and said second two-layer web so that their respective bonding fiber layers are contiguous to form a two-ply web; and

heating said two-ply web to adhere said first and second two-layer webs to each other and to form a bonded reinforcing layer.

9. A reinforced paper product according to claim 1 wherein the synthetic thermal bonding fibers have a length of from about 6 to 30 mm and a denier in the range of from about 0.5 to about 15.

10. A reinforced paper product according to claim 3 wherein the synthetic thermal bonding fibers have a length of from about 6 to about 30 mm and a denier in the range of from about 0.5 to about 15.

11. A multiple-layer reinforced absorbent papaer towel or tissue product having a basis weight in the range of from about 5 pounds to about 30 pounds per ream of 3000 square feet comprising absorbent outer layers comprised of about 40 to 95% wood pulp fibers, and

an inner reinforcing structure comprising wetlaid straight synthetic long bicomponent fibers thermally bonded to at least one said outer layer and to one another.

AMENDED CLAIMS
[received by the International Bureau on 25 June 1993 (25.06.93);
original claims 1,6,7 and 9 amended;
other claims unchanged (4 pages)]

1. A multiple-layer reinforced absorbent paper towel or tissue product having a basis weight in the range of from about 5 pounds to about 30 pounds per ream of 3000 square feet comprising

absorbent outer layers comprised predominately of wood pulp fibers, and

an inobtrusive inner reinforcing structure comprising wetlaid long straight synthetic thermal bonding fibers thermally bonded to at least one said outer layer and to one another, wherein the percentage of wood pulp fibers in said product is about 40% to about 95% by weight of all of the fibers in the product, and the percentage of long straight synthetic fibers in said product is about 5% to about 60% by weight of all of the fibers in the product.

2. A reinforced absorbent paper according to claim 1 in which said straight synthetic thermal bonding fibers compose from about 5% to about 20% by weight of all of the fibers in the web.

3. A reinforced absorbent paper according to claim 1 in which said outer layers comprise predominately hardwood and softwood kraft fibers and said inner reinforcing structure comprises long bicomponent fibers selected from the group consisting of polyethylene/polyester, co-polyester/polyester, polypropylene/polyester, and polyethylene/polypropylene.

4. A reinforced absorbent paper according to claim 3 in which the bicomponent fibers are about 1/2 inch in length and have a denier of about 2.

5. A three-layer reinforced absorbent paper according to claim 1 in which the absorbent outer layers consist essentially of wood pulp fibers and the inner reinforcing structure consists essentially of sheath/core bicomponent synthetic thermal bonding fibers.

6. A method of making three-layer reinforced paper according to claim 5, comprising the steps of:

forming first and second slurries of fibers including wood pulp fibers;

forming a third slurry of synthetic thermal bonding fibers including long synthetic thermal bonding fibers;

simultaneously wetlaying said first, second, and third slurries to form a layered web having first and second outer layers of fibers consisting essentially of said wood pulp fibers and a central layer of fibers consisting essentially of said synthetic fibers contiguous to said first and second outer layers; and

thermally bonding the synthetic fibers of the central layer to each other and to the wood pulp fibers of the first and second outer layers.

7. A reinforced absorbent paper according to claim 1 in which each of the absorbent outer layers consists essentially of the wood pulp

of said two-layer webs, wherein each of said two-layer webs consists essentially of one layer consisting essentially of wood pulp fibers and one layer consisting essentially of synthetic thermal bonding fibers.

8. A method of making a reinforced paper according to claim 7 comprising the steps of:

simultaneously wetlaying first and second two-layer webs, each two layer web including one bonding fiber layer having thermal bonding fibers;

drying said first and second two-layer webs;

creping said first and second two-layer webs;

positioning said first two-layer and said second two-layer web so that their respective bonding fiber layers are contiguous to form a two-ply web; and

heating said two-ply web to adhere said first and second two-layer webs to each other and to form a bonded reinforcing layer.

9. A multiple-layer reinforced absorbent paper towel or tissue product having a basis weight in the range of from about 5 pounds to about 30 pounds per ream of 3000 square feet comprising

absorbent outer layers comprised predominately of wood pulp fibers, and

an inner reinforcing structure comprising wetlaid straight synthetic thermal bonding fibers thermally bonded to at least one said outer layer and to one another in which each of the absorbent outer layers

thermally bonded synthetic fiber layers of said two-layer webs, wherein each said two-layer web consists essentially of one layer consisting essentially of wood pulp fibers and one layer consisting essentially of synthetic thermal bonding fibers.

10. A reinforced paper product according to claim 3 wherein the synthetic thermal bonding fibers have a length of from about 6 to 30 mm and a denier in the range of from about 0.5 to about 15.

11. A multiple-layer reinforced absorbent paper towel or tissue product having a basis weight in the range of from about 5 pounds to about 30 pounds per ream of 3000 square feet comprising absorbent outer layers comprised of about 40 to 95% wood pulp fibers, and

an inner reinforcing structure comprising wetlaid straight synthetic long bicomponent fibers thermally bonded to at least one said outer layer and to one another.

FIG. 1

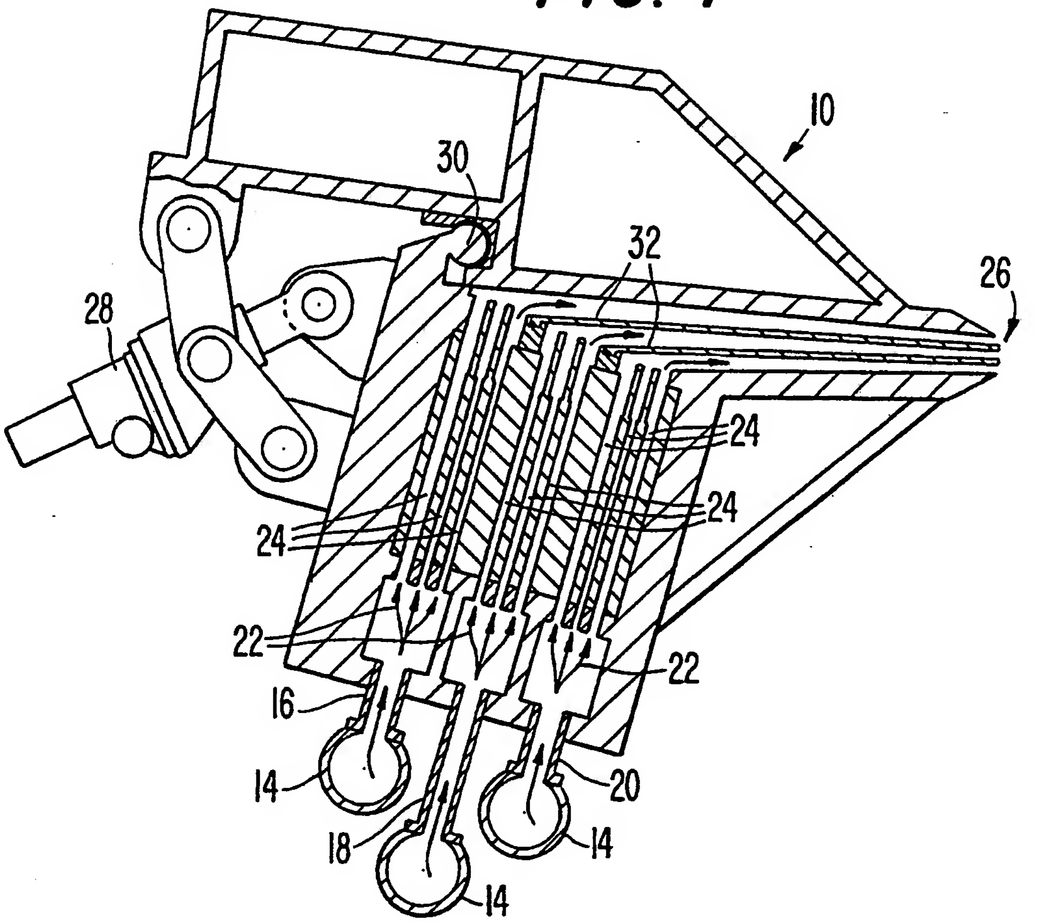


FIG. 2

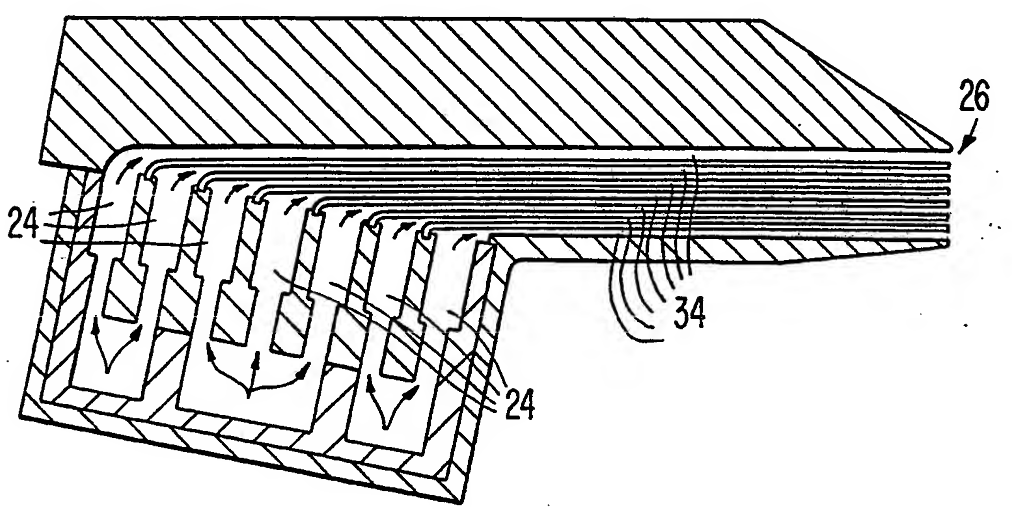


FIG. 3

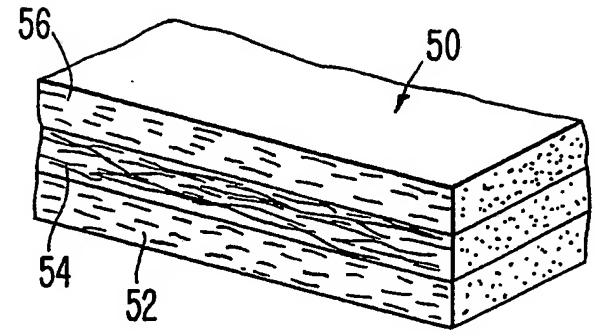


FIG. 4

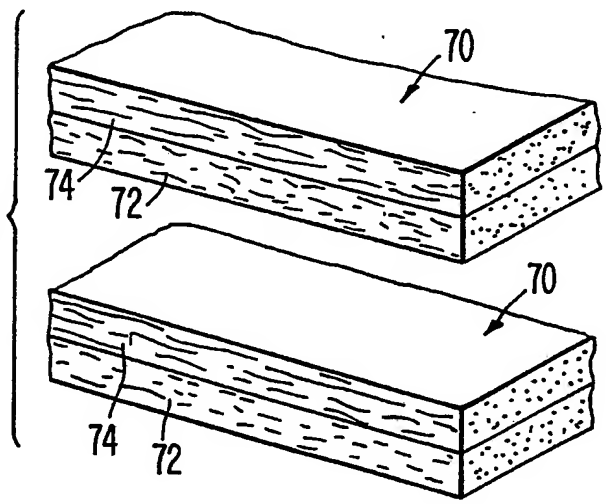


FIG. 5

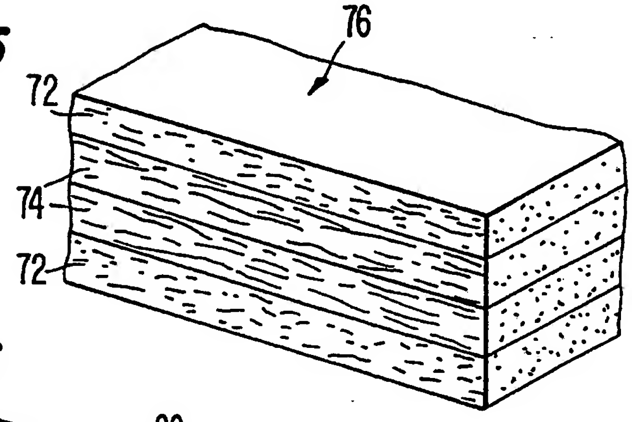
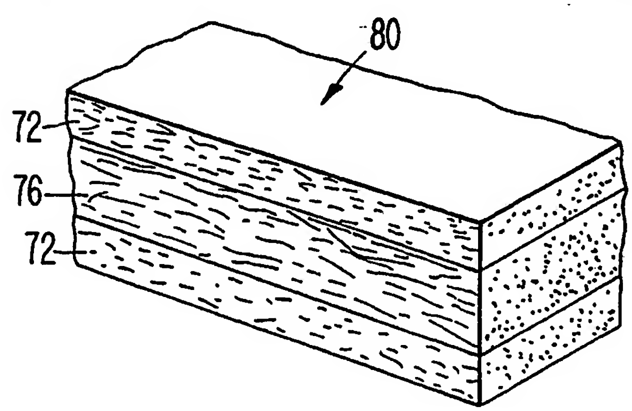


FIG. 6



INTERNATIONAL SEARCH REPORT

International Application No PCT/US 93/00205

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 D21H27/38; D21H15/10; B32B29/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	D21H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
P,X	EP,A,0 480 724 (JAMES RIVER CORPORATION OF VIRGINIA) 15 April 1992	1-5,9-11
Y	see the whole document	6
Y	US,A,4 913 773 (KNUDSEN) 3 April 1990 see claim 1	6
Y	EP,A,0 465 203 (HOECHST CELANESE CORPORATION) 8 January 1992 see the whole document	1-5,9-11
Y	DE,A,1 546 479 (VEREINIGTE PAPIERWERKE SCHICKEDANZ & CO) 26 February 1970 see claim 2	1-5,9-11

° Special categories of cited documents :[10]

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
23 APRIL 1993	12.05.93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	SONGY Odile

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

US 9300205
SA 69455

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 23/04/93
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0480724	15-04-92	None		
US-A-4913773	03-04-90	None		
EP-A-0465203	08-01-92	US-A-	5167765	01-12-92
		CA-A-	2045114	03-01-92
		JP-A-	4241193	28-08-92
		US-A-	5167764	01-12-92
DE-A-1546479	26-02-70	None		

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82